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| APPLICATION NO. | FILING DATE | FIRST NAMED INVENTOR | ATTORNEY DOCKET NO. | CONFIRMATION NO. |
|--|-------------|----------------------|---------------------|------------------|
| 10/710,706 | 07/29/2004 | Matthew S. Angyal | FIS920040028US1 | 4705 |
| 45094 | 7590 | 06/14/2005 | EXAMINER | |
| HOFFMAN, WARNICK & D'ALESSANDRO LLC THREE E-COMM SQUARE ALBANY, NY 12207 | | | HARRISON, MONICA D | |
| | | | ART UNIT | PAPER NUMBER |
| | | | 2813 | |

DATE MAILED: 06/14/2005

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary

Application No.

10/710,706

Applicant(s)

ANGYAL ET AL.

Examiner

Monica D. Harrison

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-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

- 1) ☒ Responsive to communication(s) filed on 29 July 2004.
- 2a) ☐ This action is **FINAL**. 2b) ☒ This action is non-final.
- 3) ☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

- 4) ☒ Claim(s) 1-20 is/are pending in the application.
- 4a) Of the above claim(s) _____ is/are withdrawn from consideration.
- 5) ☐ Claim(s) _____ is/are allowed.
- 6) ☒ Claim(s) 1-20 is/are rejected.
- 7) ☐ Claim(s) _____ is/are objected to.
- 8) ☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

- 9) ☐ The specification is objected to by the Examiner.
- 10) ☒ The drawing(s) filed on 29 July 2004 is/are: a) ☒ accepted or b) ☐ objected to by the Examiner.
Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).
Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).
- 11) ☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

- 12) ☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).
- a) ☐ All b) ☐ Some * c) ☐ None of:
1. ☐ Certified copies of the priority documents have been received.
2. ☐ Certified copies of the priority documents have been received in Application No. _____.
3. ☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).
- * See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

- 1) ☒ Notice of References Cited (PTO-892)
- 2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
- 3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08)
Paper No(s)/Mail Date _____
- 4) ☐ Interview Summary (PTO-413)
Paper No(s)/Mail Date. _____
- 5) ☐ Notice of Informal Patent Application (PTO-152)
- 6) ☐ Other: _____

DETAILED ACTION

Claim Rejections - 35 USC § 102

The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

A person shall be entitled to a patent unless –

(b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

Claims 1, 5, 7, 8, 10, 11, and 15 rejected under 35 U.S.C. 102(b) as being anticipated by Gilbert et al (6,576,546 B2).

1. Regarding claim 1, Gilbert et al discloses a method of preventing exposure of at least one layer of a semiconductor device, the method comprising the steps of: etching an opening through an interlevel dielectric (ILD) portion of an underlying layer and leaving a remaining cap layer (Figure 1, reference 112); maintaining the semiconductor device in an inert gas (column 7, lines 28-67 thru column 8, lines 1-8); forming a portion of a liner in the opening to prevent exposure of the ILD layer during subsequent processing (Figure 1, reference 116).

2. Regarding claim 5, Gilbert et al discloses etching through the portion of the underlying cap layer to expose a metal layer; and forming a via in the opening (Figure 1, reference 114).

3. Regarding claim 7, Gilbert et al discloses wherein the inert gas is selected from the group consisting of: argon and nitrogen (column 5, line 20).

4. Regarding claim 8, Gilbert et al discloses a method of forming a via in a semiconductor device, the method comprising the steps of: first etching an opening through an

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interlevel dielectric (ILD) layer and leaving a remaining portion of an underlying cap layer (Figure 1, reference 112); maintaining the semiconductor device in an inert gas (column 7, lines 28-67 thru column 8, lines 1-8); forming at least a portion of a liner in the opening to prevent exposure of the ILD layer (Figure 1, reference 116) second etching through the at least a portion of the liner and the portion of the underlying cap layer to expose a metal layer (Figure 1, reference 304); and forming the via in the opening (Figure 1, reference 114).

5. Regarding claim 10, Gilbert et al discloses wherein the second etching step is conducted in an etching chamber (Figure 2; column 10, lines 24-52).

6. Regarding claim 11, Gilbert et al discloses wherein the second etching is in a liner deposition chamber (Figure 2, reference 218).

7. Regarding claim 15, Gilbert et al discloses wherein the portion of the liner includes tantalum nitride (Figure 1, references 143, 146, 162, and 166).

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negated by the manner in which the invention was made.

Claims 2-4, 12-14 and 17-19 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gilbert et al (6,576,546 B2).

8. Gilbert et al disclose the cap layer of claims 2, 12 and 17 (Figure 1, reference 128) and the liner layer of claims 3, 4, 13, 14, 18, and 19 (Figure 1, reference 116). However, Gilbert et al does not disclose the specified thickness.

It would have been obvious, at the time the invention was made, for one having ordinary skill in the art to provide a cap layer with a thickness no less than 10% of the underlying cap layer and no greater than 90% along with the liner layer having a thickness of no less than 5% and approximately no more than 30% of the total liner thickness, since it has been held that where the general conditions of a claim are disclosed in the prior art, discovering the "optimum range" involves only routine skill in the art. *In re Aller*, 105 USPQ 233 (1955).

Claims 6, 9, 16 and 20 are rejected under 35 U.S.C. 103(a) as being unpatentable over Gilbert et al (6,576,546 B2) in view of Wang (2004/0198055 A1).

9. Regarding claim 16, Gilbert et al discloses a method of forming a via in a semiconductor device, the method comprising the steps of: first etching an opening through an organic interlevel dielectric (ILD) layer and leaving a remaining portion of an underlying cap layer to maintain a metal layer thereunder sealed (Figure 1, reference 112); maintaining the semiconductor device in an inert gas (column 7, lines 28-67 thru column 8, lines 1-8); forming at least a portion of a liner in the opening to prevent exposure of the ILD layer in a chamber (Figure 1, reference 116); second etching through the portion of the liner and the portion of the underlying cap layer to expose the metal layer in the chamber (Figure 1, reference 128; Figure 2); and forming the via in the opening (Figure 1, reference 138).

However, Gilbert et al does not disclose the degassing prior to the liner formation step (claims 6, 9, and 16).

Wang discloses disclose the degassing prior to the liner formation step (pg.3, paragraph 0023).

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Since Gilbert et al and Wang are both from the same field of endeavor, the purpose disclosed by Wang would have been recognized in the pertinent art of Gilbert et al.

It is obvious, at the time the invention was made, for one having ordinary skill in the art, to modify Gilbert et al with the teachings of Wang for the purpose of forming a void free ultra thick dual damascene copper feature.

10. Regarding claim 20, Gilbert et al discloses wherein the portion of the liner includes tantalum nitride (Figure 1, references 143, 146, 162, and 166).

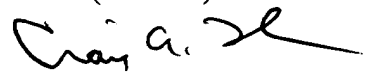
Conclusion

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Monica D. Harrison whose telephone number is 571-272-1959. The examiner can normally be reached on M-F 7:00am-3:30pm.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Carl Whitehead Jr. can be reached on 571-272-1702. The fax phone number for the organization where this application or proceeding is assigned is 703-872-9306.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see <http://pair-direct.uspto.gov>. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Monica D. Harrison
AU 2813


CRAIG A. THOMPSON
PRIMARY EXAMINER

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mdh

June 10, 2005